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IRIG STANDARD 208-85

IRIG STANDARDS
FOR
UHF COMMAND SYSTEMS

RANGE COMMANDERS COUNCIL

WHITE SANDS MISSILE RANGE
KWAJALEIN MISSILE RANGE
YUMA PROVING GROUND

PACIFIC MISSILE TEST CENTER
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frequency tolerance, modulation characteristics and frequency response, compressor mode selector, uncompressed deviation, compressed variation, modulation input impedance, distortion, harmonic and spurious emissions, undesired modulation, incidental AM, transients, carrier control, output power levels, output impedance, power monitor circuit, switching unit, manual override, automatic switching, indicating lamp, manual override, termination, transmitter monitors and controls, system indicators, test points, operating time metering, protective devices, fuses and breakers, interlocking devices, primary power characteristics. Mechanical: racks, connectors, maintainability, slide-outs. Typical antenna parameters, frequency management.

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FOR
UHF COMMAND SYSTEMS

TELECOMMUNICATIONS GROUP
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MARCH 1985



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CHAPTER 1

INTRODUCTION

1.1 General

The Telecommunications Group (TCG) of the Range Commanders Council (RCC) has prepared this document of standards to foster compatibility of ground-based UHF command transmitting equipment at all the test and evaluation (T&E) ranges under the cognizance of the RCC. The RCC highly recommends that UHF command equipment operated at the T&E ranges conform to these standards. Minimum standards for a typical antenna used with this equipment are contained in appendix A, and current frequency management policy is attached at appendix B. Utilization of the UHF spectrum for command and control of target drones has been the subject of recent regulatory changes, and future users are urged to consult current policy when planning new or replacement systems.

1.2 Scope

These standards do not necessarily define the existing capability of any test range, but constitute a guide for the orderly implementation and application of UHF command systems for test ranges. Exact equipment configurations for each individual range require a comprehensive evaluation of requirements, taking into account such factors as intended area of coverage, signal margins and terrain features.

1.3 Purpose

These standards provide development and coordination agencies with the necessary criteria on which to base equipment design and modification. The ultimate purpose is to ensure reliable and effective command coverage at RCC member ranges.

1.4 Reference Documents

Reference documents are identified at the point of reference.

1.5 Definitions

Commonly used terms are as defined in any standard reference glossary or dictionary unless otherwise indicated. Definitions of terms with special applications are included when the term first appears.

CHAPTER 2

REQUIREMENTS

2.1 System

2.1.1 Equipment Design. The Command Transmitter System (CTS) shall be fabricated from current, standard, commercial-type, solid-state equipment and components, and shall be of modular construction.

2.1.2 System Redundancy. The CTS shall be designed for redundant capability. The redundant capability shall consist of two CTSs and one switching unit. The switching unit shall be provided to effect transfer of operations between the transmitters of a dual CTS. The transfer circuitry shall be designed for automatic switching from primary to standby. A manual switching mode shall be provided to switch between primary and standby.

2.1.3 Reliability. Reliability of operation shall be considered of prime importance in the design and manufacture of this equipment. The reliability concept for this system when operated under the following environment shall result in an operational Mean Time Between Failures (MTBF) of at least 5,000 hours.

a. Ambient Temperature

- (1) Storage Limits - 40° t 160° F
- (2) Operating Limits - 10° to 115° F

b. Relative Humidity

- (1) Storage Limits - 5 to 95 percent
- (2) Operating Limits - 15 to 85 percent

c. Altitude

- (1) Storage Limits - Mean Sea Level (MSL) to 30,000 feet above MSL
- (2) Operating Limits - MSL to 10,000 feet above MSL

d. Vibration and Shock Tests. A vibration test, if deemed necessary, shall be conducted in accordance with MIL-STD-810B, Category F, Procedure VIII, Table 514.2 and Procedure VI, Figure 514.2-6. The performance of the CTS shall meet the minimum requirements of this description before and after the vibration test.

e. Burn-In Test. Each CTS and switching unit shall be preconditioned by a "burn-in" period under the following temperatures:

- (1) 30 hours at -10° F, power cycling
- (2) 30 hours at 115° F, power cycling

(3) 10 hours at -10° F, full power

(4) 10 hours at 115° F, full power

2.2 Encoder

The encoder shall be designed to generate 20 distinct audio tones and to combine any 6 of the frequencies listed in table 2-1.

2.2.1 Audio Channel. The frequency of each channel is shown in table 2-1.

TABLE 2-1
ENCODER FREQUENCIES

<u>Audio Channel</u>	<u>Frequency (kHz)</u>	<u>Audio Channel</u>	<u>Frequency (kHz)</u>
1	7.50	11	25.01
2	8.46	12	28.21
3	9.54	13	31.83
4	10.76	14	35.90
5	12.14	15	40.49
6	13.70	16	45.68
7	15.45	17	51.52
8	17.43	18	58.12
9	19.66	19	65.56
10	22.17	20	73.95

2.2.2 Channel Activation. The 20 audio channels shall be activated by either local or remote controls. A local/remote control switch shall be provided on each encoder. In the local position, 20 individual switches shall be provided to activate any combination of audio channels. In the remote position, 20 individual remote control lines shall activate any combination of audio channels. The remote keying circuitry shall provide individual voltage inputs to each channel. The output of each channel shall be activated (ON) by an application of +10 to +30-volts d.c. to the respective remote keying inputs, and shall be deactivated (OFF) when the voltage level is reduced to +5-volts d.c. A voltage necessary to effect this control shall be furnished at the remote input of the decoder.

2.2.3 Composite Signal. The composite signal shall be generated by linear addition of activated audio tones. A high impedance output of 20,000 ohms, + 5 percent and a low impedance output of 600 ohms, + 5 percent, shall be provided. The individual output connectors shall be provided on the front panel of the unit, and each shall mate with a BNC type UG/88U.

2.2.4 Composite Output. The composite output of the encoder shall be continuously adjustable from 0 to 2 volts into a matched load. The composite output shall have a linear mode of modulation in which the input tones shall be additive.

2.2.5 Frequency/Adjustment. Each audio tone shall be adjustable to the center frequency.

2.2.6 Long-Term Frequency Stability. The frequency stability of each channel shall remain within ± 0.01 percent of its allocated channel frequency for an 8-hour duration of continuous operation after an initial 15-minute warmup.

2.2.7 Short-Term Frequency Stability. The frequency stability of each channel shall remain within ± 0.01 percent of its allocated channel frequency for a 5-minute duration of continuous operation after an initial 15-minute warmup.

2.2.8 Amplitude Adjustment. The output voltage amplitude of each individual channel shall be adjustable to within ± 2 percent of an internally preset value and have a range of ± 6 dB of the preset value.

2.2.9 Amplitude Stability. The output voltage amplitude of each individual channel, as well as the composite output formed by all combinations of channels, shall have an amplitude stability of ± 10 percent of any preset value.

2.2.10 Keying Lamp Monitor. An individual monitoring lamp shall be provided to indicate keying of individual channels and shall be located on the front panel of the encoder.

2.2.11 Controls, Amplitude and Frequency. The control of the composite output level shall be located on the front panel. The amplitude control for the individual channels shall be within the chassis.

2.2.12 Response Time, Channel Amplitude. Upon application of voltage (see subparagraph 2.2.2), the response time of the amplitude output of a keyed channel shall be 90 percent of its continuously keyed level within 1.0 millisecond. Upon removal of voltage, the amplitude output shall be decreased by at least 90 percent of its keyed value within 1.0 millisecond.

2.2.13 Harmonic Distortion. The harmonic distortion of individual channel outputs shall not exceed 1.0 percent.

2.2.14 Supply Unit. The encoder shall be designed to operate on a single-phase, 115-volt a.c. (± 10 percent) power source at 60 Hz (± 10 percent). A main power switch, fuse, and lamp indicator shall be located on the front panel of the command encoder. The a.c. power lead-in cable shall enter through the rear panel of the unit.

2.3 Transmitter

2.3.1 Frequency Range. The transmitter shall be tunable over the frequency range of 420 to 450 MHz in 0.1-MHz steps. The operating frequency shall be selected by a direct-reading front panel control. Calibrated tuning dials shall be included for realignment of appropriately tuned circuits. Refer to appendix B for additional frequency restrictions.

2.3.2 Carrier Frequency Tolerance. The carrier frequency tolerance, including accuracy and stability, shall not be greater than ± 0.0005 percent of the selected carrier frequency over a period of 24 hours of continuous or intermittent operation.

2.3.3 Modulation Characteristics. The modulator of the transmitter shall be capable of providing a frequency modulated signal with deviation continually adjustable by a front panel control. It shall be capable of operating in either a compressed or uncompressed (linear) mode.

2.3.3.1 Modulating Frequency Response. The response of the transmitter modulator to input signals shall be flat within ± 3.0 dB from 10 Hz to 100 kHz with no compression. The response with compression shall be flat within ± 3.0 dB from 2 kHz to 75 kHz.

2.3.3.2 Compressor Mode Selector. A circuit shall be provided for by-passing the compressor stage. The compressor by-pass switch shall be located on the front panel.

2.3.3.3 Uncompressed Deviation. The deviation when operating in the uncompressed mode shall be adjustable from 0 to ± 300 kHz when a 2.0 volt peak-to-peak, 10 Hz to 100 kHz signal is applied to the external modulation input. The deviation control shall be located on the front panel. The deviation shall not vary from a preset level more than ± 5 percent over 24 hours of continuous or intermittent operation.

2.3.3.4 Compressed Variation. The peak-to-peak frequency deviation limit shall be adjustable from ± 15 to ± 300 kHz when the modulation compressor control switch is activated. The modulation compressor circuit shall operate post-circuit to, but in conjunction with, the linear deviation control circuit. In this configuration, the compressed frequency deviation shall be identical, except for frequency response, to the linear frequency deviation until 80 percent deviation of the set peak limit is attained. Increased input resulting from tone combination shall be attenuated linearly so that the peak deviation shall not exceed the set limit by ± 0 to ± 10 percent.

2.3.3.5 Modulation Input Impedance. Two modulation inputs shall be provided with 600-ohm resistive and 20,000-ohm resistive, unbalanced to ground. The modulation receptors shall mate with a BNC type UG/880 coaxial cable connector and shall be mounted on the front panel of the unit.

2.3.4 Distortion. The harmonic distortion and the intermodulation distortion shall not exceed 2.0 percent and 1.0 percent, respectively, over the frequency deviation range.

2.3.5 Harmonic and Spurious Emissions. The harmonic and spurious emissions at the transmitter output shall not exceed limits of 50-dB and 90-dB, respectively, below rated power output. The radiation level of spurious, fundamental and harmonic emanations shall not exceed 100 microvolts per meter within a 100-foot radius of the system when terminated in a matched load. The emission limit shall apply to all frequencies between 150 kHz and 10,000 MHz under zero and full modulated operating conditions.

2.3.6 Undesired Modulation. The residual FM over the baseband of 10 Hz to 100 kHz, including random noise, shall not exceed ± 5 percent. Any discrete undesired modulation component (frequency) greater than 300 Hz and less than 120 kHz shall be at least 50-dB below 30-kHz reference peak deviation.

2.3.7 Incidental AM. Incidental amplitude modulation of the carrier shall not exceed 5 percent of the preset power level.

2.3.8 Transients. Transients generated by powerline-conducted noise or by the effects of internal switching shall be less than 1.0 percent of the desired (set) deviation level at the end of one cycle of the fundamental frequency of the disturbance.

2.3.9 Carrier Control. Carrier keying shall be provided for carrier control from both the transmitter front panel and a remote carrier control terminal. The remote control terminal shall be mounted on the back panel of the transmitter unit. The carrier shall be ON when either the front panel control or the remote control is in the ON position, and the carrier control shall be in the form of a closed (carrier ON) and open (carrier OFF) relay. The carrier output in the OFF state shall not exceed 120-dB down from the rated output level.

2.3.10 Output Power Levels. The transmitter shall be designed for two optional models providing 100-watt and 1-kilowatt power outputs. The design shall be modular so that the same exciter is used for the two models. The output power shall be adjustable by front panel control on the exciter over a range of 10 dB. The output power stability shall be ± 5 percent of the preset level. The CTS shall incorporate a circulator/isolator located between the driver and the final amplifier stage. This circulator/isolator shall be designed and installed to allow removal of the driver to be operated on an antenna as well as into the final amplifier without damage.

2.3.11 Output Impedance. The transmitter shall operate into a 50-ohm load with a VSWR of up to 2:1.

2.3.12 Power Monitor Circuit. A power level monitor circuit shall be provided to continuously monitor incident or reflected power at the RF output. The monitored power shall be used to drive the panel-mounted RF power meter.

2.3.13 Switching Unit. A switching unit shall be provided to effect bilateral transfer of operation between two transmitters of a dual CTS. The transfer circuitry shall be designed for automatic switching from primary to standby and manual switching between primary and standby.

2.3.13.1 Manual Switching. A switch shall be provided on the switching unit for manual selection of transmitter.

2.3.13.2 Automatic Switching. The automatic switching mode shall be activated when a 6-dB power change occurs in the rated RF output level of the "on-line"

transmitter of the dual transmitter system. The switching time shall not exceed 50 milliseconds. Transfer of operation shall not occur when a similar power difference is present in the "standby" transmitter.

2.3.13.3 Indicating Lamp. The switching unit shall be provided with light indicators and an audio alarm to denote operational status of transmitters and change of operation action, respectively. A switch shall be provided to disable the audio alarm.

2.3.13.4 Manual Override. A manual override of the automatic switching shall be provided.

2.3.13.5 Termination. The switching unit shall have automatic RF switching so that the transmitters can be terminated into a single antenna system as well as separate antennas.

2.3.14 Transmitter Monitors and Controls. For easy access by the site operator, as many controls and monitors shall be grouped together as possible. The controls and monitors that must be located on individual components shall be located on the front panel of that component.

2.3.14.1 System Indicators. An indicating system denoting tuning and operational status of the transmitter shall be located on the front panel of the unit. A deviation level indicator and a forward and reflected RF power indicator shall be included in the system. The deviation measurement shall be taken from the modulated RF carrier. The indicating devices for registering tuning and operational functions as well as for plate, screen grid, and grid currents or appropriate parameters shall indicate the actual forward output of the transmitter with an accuracy of ± 10 percent of the maximum power indication. The deviation meter shall have two scales: 0 to 30 kHz and 0 to 300 kHz. The deviation meter shall indicate carrier peak deviation to an accuracy of ± 5 percent of maximum deviation for any number of IRIG tones from 1 to 6.

2.3.14.2 Test Points. A sufficient number of readily accessible and properly identified test points shall be provided to facilitate rapid troubleshooting, setup and adjustment of each exciter.

2.3.15 Operating Time Metering. Elapsed time meters (nonresettable type) shall be provided to record the electrical power time on and RF carrier time on.

2.3.16 Protection Devices

2.3.16.1 Fuses and Breakers. All electrical power circuits shall be protected against overloads by fuses/circuit breakers; each shall be positioned for ease of replacement/resetting purposes. Fuses shall be mounted on the front panel and be the indicating type.

2.3.16.2 Interlocking Devices. All doors to access parts where hazardous voltage potential exists shall be equipped with interlocking devices.

2.3.17 Primary Power Characteristics. The exciter and the 100-watt power amplifier of the transmitter shall operate as specified with a primary power source of 115-volts RMS (+15-volts RMS), 60-Hz (+10 percent), single-phase, 2-wire plus ground wire. The 1-kilowatt and 10-kilowatt amplifiers shall operate as specified with a power source of 208 volts (+ 20 percent) RMS, 60-Hz (+10 percent), 3-phase, wye connected.

2.4 Mechanical

2.4.1 Racks. Each command transmitter system shall be designed for mounting in a rack not more than 36-inches wide by 72-inches high. The depth (including mating connectors) of the transmitters and switching unit shall not exceed 36 inches. The racks shall be furnished by the contractor.

2.4.2 Connectors. All input and output connectors shall have mating connectors supplied.

2.4.3 Maintainability. The equipment shall be arranged to provide rapid access to system components and other parts. The components and parts shall be installed so that other components or parts need not be removed to gain access to a specific component or part. This does not include shielding.

2.4.4 Slide-Outs. The connector shall furnish slide-out support assemblies for ease in operational maintenance of major items of equipment. The system shall be operable regardless of whether the slide-out assemblies are in the extended or retracted positions.

APPENDIX A
TYPICAL ANTENNA PARAMETERS

The following is a list of minimum standards required for a typical antenna used in conjunction with the Command Transmitter System (CTS). The antenna described is a Log Spiral UHF antenna.

Frequency Range:	406 MHz to 550 MHz
Pattern:	Hemispherical
Polarization:	Left and circular
Axial Ratio:	3-dB average, 6-dB maximum
Input Power:	1 kW-CW (continuous)
Weight:	40-lb maximum
Height:	66-in maximum
Width:	20-in maximum
Input Connector:	N-female
Deviation from OMNI on Horizon:	<u>±</u> 3-dB maximum
Gain:	0-dB average over hemisphere
Input Impedance:	50 ohms
VSWR:	1.75 maximum

APPENDIX B
FREQUENCY MANAGEMENT POLICY

The following policy is established with respect to use of the bands between 406.1 and 550 MHz by target drones, as published in the Manual of Regulations and Procedures for Federal Radio Frequency Management, National Telecommunications and Information Administration, Department of Commerce.

1. Target drones may be supported in the 420-450-MHz band on a continuing basis.

2. Operations of all target drones in the band 450-550 MHz will cease not later than 31 December 1982. Extensions of existing assignments may be made on a renewable basis to expire 31 December 1982; no extension of this authority will be considered.

3. Target drones may continue to operate in the 406.1-420 MHz band until 31 December 1987, in designated and controlled military test and training test areas and firing ranges on land and at sea. Target drones will operate in this band on a nonprotected, noninterference basis to current and future operations conducted in accordance with the National Table of Allocations.

4. Target drone operations will be limited to designated military ranges and training areas.

5. Target drone operations will be reaccommodated from the 406.1-420 MHz band by 31 December 1987, and from the 450-550 MHz band by 31 December 1982 into the 420-450 MHz band or other appropriate bands. No extension of authority to use 406.1-420 MHz and 450-550 MHz bands will be considered.

6. No new procurement of transmitting and receiving equipment in support of target drones in the bands 406.1-420 MHz and 450-550 MHz will be initiated.